VARIATIONS IN THE STABLE CARBON ISOTOPIC COMPOSITION OF TROPICAL PACIFIC SURFACE WATERS

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ABSTRACT

The $\delta^{13}C$ distribution of total dissolved inorganic carbon in surface waters between Hawaii and Tahiti has been investigated. The study was undertaken to determine the temporal and spatial changes in the $\delta^{13}C$ distribution of tropical Pacific surface waters and the relative importance of the various biological, chemical and physical processes that control the distribution.

All of the surface waters sampled were in carbon isotopic disequilibrium with the atmosphere. The measured distributions were all characterized by an equatorial $\delta^{13}C$ minimum that is produced by the upwelling of ^{13}C depleted water. Increases in both $\delta^{13}C$ and the extent of carbon isotopic disequilibrium between the atmosphere and surface ocean occurred on both sides of the equator to about 6-13°N and about 8-15°S latitude. Polewards of these latitudes the surface ocean $\delta^{13}C$ composition decreased towards isotopic equilibrium with the atmosphere.

The $\delta^{13}C$ increases apparently result from the flux of ^{13}C depleted organic carbon out of the mixed layer and to a lesser extent, kinetic isotope effects associated with the air-sea exchange of carbon dioxide. Farther from the equator, nutrient depletion in surface waters reduces the organic carbon flux and air-sea gas exchange becomes more important in affecting the surface water $\delta^{13}C$ composition. Eventually, isotope fractionations associated with the air-sea exchange of carbon dioxide cause the $\delta^{13}C$ composition of the surface waters to decrease towards isotopic equilibrium with the atmosphere.

Fluctuations in the surface water $\delta^{13}C$ distributions occurred over a period of months and can be explained in terms of variations in the intensity of equatorial upwelling and the resultant effects on both the flux of nutrients to the surface mixed layer and the extent of carbon dioxide disequilibrium between the atmosphere and surface ocean.

Measurements of $\delta^{13}C$ in surface waters have been made over a 21 h period at a station in the region of equatorial upwelling and over a 24 h period at a station in the oligotrophic ocean off Hawaii. No significant changes in $\delta^{13}C$ with time were observed at the station occupied off Hawaii. Consistent increases in $\delta^{13}C$ in the upper 100 m of the water column were measured during the daytime at the station near the equator. Rates of ecosystem production calculated from the increases are greater than productivities measured in the region using conventional ^{14}C measuring techniques.